

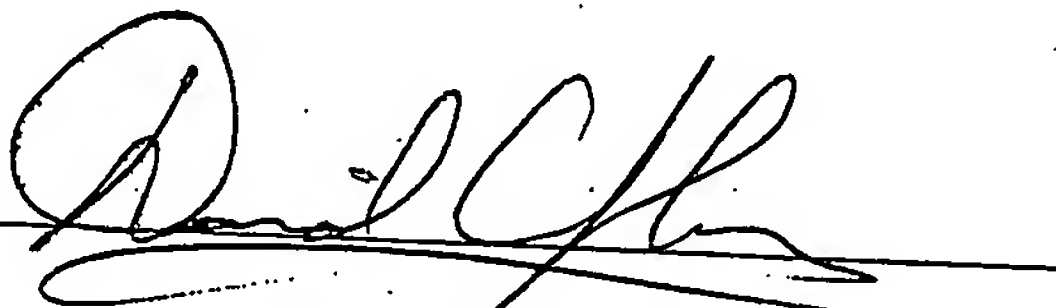
VERIFICATION OF TRANSLATION

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declare that I am a professional translator well acquainted with both the German and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of the accompanying German document.

Signature



David Clayberg

Date

5/9/06

Method and Device For Producing Screw Connections

Prior Art

5 The invention is based on a method and device according to the
preambles to claims 1 and 8.

 Proposals have already been made to measure, monitor, and document
the torque achieved by electrically driven and electronically controlled
10 screwdrivers. To this end, the controllable screwdrivers have means, in
particular torque sensors and/or rotation angle sensors that detect the
measurement values and supply them to a regulation circuit. Depending on the
parameters measured, the screw driving process is automatically terminated
when the predetermined values are achieved. There are also known cutout
15 screwdrivers that are deactivated by means of a mechanical clutch.

 Screwdrivers of this kind are used on a large scale in industrial production.
Since it is frequently the case that numerous screw driving operations must be
performed in many production steps of the production process, there is the
20 danger of some screw driving operations being inadvertently omitted. Monitoring
the correct execution of screw driving operations can be achieved by counting
the number of correct screw driving operations per screw driving cycle, e.g. per
production step or per component, but this requires detection of the screw driving
procedures. It is therefore necessary to differentiate between correctly executed
25 screw driving operations and an idle screwdriver actuation in which the operator
does in fact actuate the starting switch of the screwdriver, but without screwing in
a screw. An idle screwdriver actuation of this kind can occur, for example,
between two screw driving procedures, when the operator tests the functionality
of the screwdriver or inadvertently actuates the start switch. An idle screwdriver
30 actuation can also occur if the screw driving procedure is prematurely
terminated.

Advantages of the Invention

The invention is based on a method for producing a screw connection by means of a cutout screwdriver that terminates a screw driving operation when a predetermined torque is achieved.

According to the present invention, data relating to an operation are detected in the cutout screwdriver and transmitted to an external monitoring unit. Preferably, operating data are collected internally in the cutout screwdriver and transmitted to the external monitoring unit. It is suitable for this to occur by means of radio transmission. A transmission via cable, however, is also conceivable. If the data lie outside a tolerance range, then an error message can be issued and in particular, the cutout screwdriver can be deactivated.

If the data are detected and/or evaluated by means of an evaluation circuit and transmitted to the monitoring unit, if the monitoring unit receives the transmitted data and evaluates them with regard to predetermined limit values, and if, when the data do not comply with the limit values, an error message is generated, then a reliable quality control of the cost screwdriver can be achieved, particularly in a production process on an assembly line. Preferably, the error message is constituted by the deactivation of the cutout screwdriver.

Preferably, data relating to the operation, in particular relating to correctly executed screw driving operations and those not executed, are detected, and, in the event that a number of screw driving operations lie outside a tolerance range, the cutout screwdriver is deactivated. This has the advantage that the deactivation of the cutout screwdriver prevents the operator from continuing work until the error in the screw driving cycle has been rectified. This improves quality control and reduces the amount of waste due to unsuccessful screw driving operations. Preferably, the data are detected by means of an evaluation circuit

and transmitted to a monitoring unit, in particular an external monitoring unit situated apart from the cutout screwdriver. Preferably, the evaluation circuit detects and evaluates whether or not a screw driving operation has been successfully executed. For example, the evaluation circuit sends the monitoring unit a "screw driving operation correct" or "screw driving operation incorrect" signal. The monitoring unit detects the data and evaluates them with regard to predetermined limit values. If the data lie outside the tolerance range, then a corresponding signal is sent to the cutout screwdriver.

It is also optionally or additionally possible for other data deemed useful to those skilled in the art to be transmitted from the cutout screwdriver to the monitoring unit, in particular operating data of the cutout screwdriver, such as whether a screw driving operation has been completed, whether a screw driving operation was correct or incorrect, and/or the time and/or date when a screw driving operation was carried out, and/or a duration of the screw driving procedure, and/or a duration of an entire cycle, e.g. a certain number of screw driving operations per screw driving cycle, and/or limit values of a current consumption and/or voltage drop during the screw driving operation as a measure for the quality of the screw driving operation, and/or information regarding a loosening or tightening of a screw, i.e. by an actuation of the clockwise or counterclockwise operation of the cutout screwdriver. It is also advantageous to switch off and/or deactivate the cutout screwdriver when it is taken out of an operating range of the external monitoring unit or to activate the cutout screwdriver when it is brought into the operating range of the monitoring unit. It is useful for the cutout screwdriver to log onto the monitoring unit by transmitting a signal.

Detecting the data in an external monitoring unit that is coupled, for example, to a computer makes it possible for the data to be detected and evaluated in an on-line fashion. Through comparison with certain limit value criteria, the quality of screw driving operations, for example, is checked and,

when limit value criteria are not met, a correction of the screw driving operations is required.

It is possible for a torque sensor in the cutout screwdriver to detect current
5 torques and transmit them to the evaluation circuit, which, based on whether a
desired torque has been achieved or not, determines whether a screw driving
operation has been executed correctly. If the duration of a usual screw driving
operation is known, then the duration for the screw driving operation can be used
as a criterion for assessing whether or not a screw driving operation has been
10 successfully performed. If no screw driving operation is detected after a
predetermined amount of time, i.e. the cutout screwdriver does not switch off or
switches off too late, then this can indicate an incorrect screw driving operation.
On the other hand, if the cutout screwdriver switches off too early, then this can
also indicate an incorrect screw driving operation. These data are preferably
15 transmitted to the monitoring unit. It is also possible to use other measurement
values deemed appropriate to detect an incorrect screw driving operation.

It is useful for the number of screw driving operations per screw driving
cycle to be detected in the evaluation circuit. In an advantageous modification,
20 the duration of the screw driving operation is detected in the evaluation circuit.
Optionally or additionally, the current consumption and voltage drop of the cutout
screwdriver during a screw driving operation can be detected in the evaluation
circuit. It is particularly preferable not only to detect these data, but also to
evaluate them as either correct or incorrect.

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Preferably, the detected and evaluated data of the evaluation circuit are
transmitted to the external monitoring unit by means of a transmitter. One
advantage of an external monitoring unit is that a single monitoring unit can be
used to monitor a multitude of cutout screwdrivers, in particular cordlessly
30 operated cutout screwdrivers, which is an advantage, for example, in a
production line. To this end, each of the multitude of monitored cutout

screwdrivers has a corresponding code for unique identification, which is known to the monitoring unit. It is also conceivable, however, for the cutout screwdriver to be connected to the monitoring unit via a cable and for data to be transmitted between the cutout screwdriver and the monitoring unit via the cable. If need be, 5 the cable can also be used to supply current to the cutout screwdriver.

Preferably, limit values for the data transmitted from the evaluation circuit are stored in the monitoring unit, with which the transmitted data are compared and evaluated. When limit value criteria are not met, the monitoring unit sends 10 the cutout screwdriver a signal that deactivates the cutout screwdriver.

The present invention also proposes a device for carrying out a method in which a cutout screwdriver is connected to an evaluation circuit that is coupled via a transmitter to an external monitoring unit. Preferably, the cutout 15 screwdriver has a receiver, which, in conjunction with a transmitted signal, interrupts the supply of current to the cutout screwdriver.

Preferably, the monitoring unit has a transmitter/receiver system that receives the data transmitted from the evaluation circuit and transmits a 20 deactivation signal to the cutout screwdriver. In particular, the transmitter/receiver system of the monitoring unit can communicate with a transmitter/receiver system of the cutout screwdriver.

It is advantageous if the monitoring unit has an evaluation unit in which 25 the data transmitted from the evaluation circuit are stored, compared with limit values for the transmitted data, and evaluated. When limit value criteria are not met, the evaluation unit sends the cutout screwdriver a signal that causes a control unit to disconnect the supply of current to the cutout screwdriver. Preferably, the evaluation unit is a computer that processes the data in an on- 30 line fashion.

The present invention is particularly suitable for cordless cutout screwdrivers and is particularly advantageous for cordless screwdrivers used in industrial applications.

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Drawings

Independent of the combinations in which they appear in the claims and without limitation to their general applicability, other embodiment forms, aspects,
10 and advantages of the present invention also ensue from the exemplary embodiments of the invention described below in conjunction with the drawing.

Fig. 1 schematically depicts the design of an exemplary embodiment of a device according to the present invention.

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Description of the Exemplary Embodiment

Fig. 1 depicts a device in which a cutoff screwdriver 10 is embodied in the form of a cordless cutout screwdriver. The cutout screwdriver 10 has a torque
20 sensor 12 for detecting the torque of the motor 14. The cutout screwdriver 10 also has a control unit 16 that switches the motor 14 on or off and prompts the motor 14 to execute a clockwise or counterclockwise operation. It is also optionally possible for the control unit to control the output and speed of the motor 14.

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The torque sensor 12 and control unit 16 are connected to an evaluation circuit 18 that is only indicated here; in particular, the evaluation circuit 18 can be integrated into the cutout screwdriver 10. The evaluation circuit 18 detects and decides whether or not a screw driving operation has been correctly executed
30 and sends a corresponding signal to an external monitoring unit 20. It is

optionally possible for the evaluation circuit 18 to detect and decide whether or not other operating data of the cutout screwdriver 10 are correct.

The torque rises as the screw driving operation continues such that at the moment at which the head of the screw comes into contact with the parts to be joined, the torque increases. The torque increases to a desired torque at which the cutout screwdriver 10 should be deactivated. By means of the evaluation circuit 18, the current data are detected and evaluated as "screw driving operation correct" or "screw driving operation incorrect".

If the cutout screwdriver 10 is functioning in idle mode, then the idle mode is associated with a particular idle torque that is less than the desired torque.

If the final torque of the cutout screwdriver 10 is less than the desired torque, then an idle screwdriver actuation is occurring, which is counted in the evaluation circuit 18 and evaluated as incorrect. If the desired torque is achieved, then a correct screw driving is occurring, which the evaluation circuit 18 likewise detects and evaluates to be a correct screw driving operation.

In addition, the evaluation circuit 18 detects the duration of the screw driving operation as well as the current consumption and voltage drop during the screw driving operation.

A transmitter in the evaluation circuit 18 transmits the detected and evaluated data to an external monitoring unit 20. The monitoring unit 20 has an evaluation unit 22 equipped with a transmitter/receiver system that is able to receive the data transmitted from the evaluation circuit 18 and to transmit, as needed, a deactivation signal to the cutout screwdriver 10. For example, the evaluation unit 22 is a computer that processes the data in an on-line fashion.

The evaluation unit 22 of the monitoring unit 20 stores the data transmitted from the evaluation circuit 18. The transmitted data are compared to limit values stored in the evaluation unit 22 and evaluated.

- 5 If limit value criteria are not met, then the evaluation unit 22 sends the cutout screwdriver 10 a signal, which causes the control unit 16 to interrupt the supply of current in the cutout screwdriver 10.

- 10 For example, if the number of idle screwdriver actuations exceeds a predetermined limit value per screw driving cycle, then the cutout screwdriver 10 is deactivated. If the limit values from current consumption to voltage drop are not achieved during the screw driving operation, which represents a measure for the quality of the screw driving operation, then the cutout screwdriver 10 is deactivated and the operation is interrupted. The control unit 16 allows the
15 operator to continue the screw driving operation, but only permits successful completion of the screw driving cycle if the error has been rectified. If the error source has not been remedied, then the monitoring unit 20 deactivates the cutout screwdriver 10 again.

- 20 It is also possible for the cutout screwdriver 10 to be deactivated when it is taken out of the operating range of the monitoring unit 20 and for it to be activated when it is brought into the operating range of the monitoring unit 20.